Abstract View

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The Southern Ocean Momentum Balance: Evidence for Topographic Effects from Numerical Model Output and Altimeter Data

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ABSTRACT

The momentum balance of the Antarctic Circumpolar Current is investigated using both output from a high-resolution primitive equation model and sea surface height measurements from the Geosat altimeter. In the Semtner–Chervin general circulation model, run with approximately one-quarter degree resolution and time-varying ECMWF winds, topographic form stress is the dominant process balancing the surface wind forcing. Detailed examination of form stress in the model indicates that it is due to three large topographic obstructions located at Kerguelen Island, Campbell Plateau, and Drake Passage. The difference between wind stress and form stress represents the lateral transfer of momentum into and out of the ACC. It is examined both in zonal coordinates to conform to the model architecture and along mean streamlines in order to reduce the effects of standing eddies. In this particular model, in stream coordinates, biharmonic friction dominates the lateral transfer of momentum. Since biharmonic friction is a parameterization of subgrid-scale transient eddy processes, this indicates that the unresolved transient eddy processes play a critical role in fluxing momentum across the ACC in this model. Although the relative importance of individual terms in the momentum balance does not vary substantially along streamlines, elevated levels of eddy kinetic energy are associated with the three major topographic features. In contrast, altimeter data show elevated energy levels at many more topographic features of intermediate scales, suggesting that smaller topographic effects are better able to communicate with the surface in the real ocean than in the model.